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Contributions to the Mesozoic flora of the Atlantic coastal plain — II. North Carolina *

EDWARD WILBER BERRY

(WITH PLATES 11-16)

Although Winchell mentioned the occurrence of fossil plants in Alabama as long ago as 1856,[†] and Meek & Hayden refer to them in 1857,[‡] the first collections were made, so far as I am aware, as recently as 1884. These were sent to Lesquereux. Subsequently additional collections were made by Smith, Langdon, Fontaine, and Ward, but none of these have ever been studied, although Ward furnished Smith with a provisional list of thirty-five species which was published on page 348 of his *Geology of the Coastal Plain of Alabama* in 1894.

These plants conclusively prove the Mid-Cretaceous age of that part of the Tuscaloosa formation from which they were collected, although it is quite possible that the great thickness assigned to this formation by the Alabama geologists may indicate the presence of beds of Older Potomac age, especially since beds of this age are now definitely known from both North and South Carolina, and are said by Darton to be present in Georgia.

The most southerly outcrops heretofore known of plant-bearing beds of Raritan or Magothy age, with which the Alabama beds are comparable, are those found in Maryland, and it is the purpose of the present paper partially to bridge over this interval of nearly eight hundred miles, and to add another link to the chain which has come to connect the Cretaceous floras of Marthas Vineyard, Block Island, Long Island, Staten Island, New Jersey, Delaware and Maryland.

No Cretaceous plants have ever been described from North Carolina, although we find lignite mentioned by Olmsted as early as 1827 as occurring along the Neuse river.§ In Emmons's first

* Published by permission of the North Carolina Geological Survey.

† Proc. Am. Assoc. Adv. Sci. 10²: 92. 1856.

‡ Proc. Acad. Nat. Sci. Phila. 9: 133. 1857.

§ OLMSTED, D. Rep. Geol. N. C. part 2. 1827.

report * petrified wood and lignite are recorded along the Cape Fear river about 18 miles above Fayetteville. Kerr publishing in 1875 † writes of the lignitic beds of the Cape Fear river and mentions the occurrence of "trunks, limbs and leaves of trees," correctly correlating the deposits with similar exposures on the Neuse river near Goldsboro, North Carolina.

Darton, publishing in 1895, in a footnote on page 517, ‡ says that Ward had discovered plant remains of Potomac age along the Cape Fear river, although the latter author in a recent publication § states that no characteristic fossil plants have been found in the Potomac of North Carolina. On page 390 of the same work occurs the following paragraph :

"The higher beds farthest down the river yield imperfect specimens of dicotyledonous leaves having affinities with those of the Newer Potomac and are doubtless of that age, but those at Lafayette || and for ten or perhaps twenty miles below, though apparently barren, closely resemble Older Potomac strata, but are transgressed by marine deposits which occupy the top of the bluffs nearly the whole distance."

The first part of this paragraph refers, I suppose, to the lignitic layers such as occur at Big Sugar Loaf Landing, fifty miles below Fayetteville. No leaves appear to have been discovered near Fayetteville, where they are abundant and well preserved. If the latter part of the paragraph just quoted refers to the overlying Pleistocene it may possibly be true; if it refers to the laminated clays and sands of Cretaceous age, it should be added by way of comment, that while they do transgress the Older Potomac at several points, by no means are they uniformly present along the tops of the bluffs, and they are far from being typically marine deposits. Farthest down the river, where the lignitic Cretaceous first appears below the typically Marine Cretaceous, it contains sharks' teeth and other marine remains, but as you come up the river, getting lower and lower in the formation, it becomes more

* MCLENAHAN, in Emmons, Rep. Geol. Surv. North Carolina, 173. 1852.

† KERR, W. C. Rep. Geol. Surv. N. C. 1 : 148, 149. 1875.

‡ DARTON, N. H. Bull. Geol. Soc. Am. 7 : 517. 1895.

§ WARD, L. F. U. S. Geol. Surv. Monog. 48 : 374. 1906.

|| This must be intended for Fayetteville, as there is no town of Lafayette on the Cape Fear river.

and more transitional in character, until where it rests upon the Older Potomac it is clearly estuarine. In spite of inaccuracies of detail, however, the inference is correctly drawn that these upper beds are comparable with the Tuscaloosa formation of Alabama (*loc. cit.* 391). The foregoing in a very brief way exhausts the references to the Cretaceous flora of North Carolina.

During the past summer the writer, under the auspices of the North Carolina Geological Survey, made a reconnaissance by boat from the Piedmont to the coast along the Roanoke, Neuse and Cape Fear rivers in North Carolina and the Great Pee Dee in South Carolina. By far the most instructive section is the more or less well known one along the Cape Fear, and while it is not my purpose to discuss the geology in this place, a word or two of explanation is necessary.

In ascending the Cape Fear the Transitional Cretaceous, which consists of very lignitic sands and laminated clays and sands, greatly crossbedded in places and carrying pyrite and glauconite, was first seen in the vicinity of Donohue Creek Landing, about fifty miles above Wilmington. From this point it is exposed at frequent intervals almost as far up as Fayetteville, a distance of over fifty miles, coming to lie with a marked unconformity upon the Older Potomac beds which form the river bluffs for some fifteen miles below that place. As we ascend the river, getting lower down in the formation, all evidences of marine conditions of deposition disappear, the beds becoming littoral and estuarine in character.

Leaf-remains were observed at a number of points, in most cases the impressions carrying too much lignite and the matrix being too coarse to permit of their successful collection and preservation. Near Court House Landing, about seventy-six miles above Wilmington in Bladen County, these Transition beds reach a thickness of about seventy feet and contain lenses of rather compact brownish drab clay carrying good leaf-impressions which have furnished the bulk of the species enumerated in the following pages. Similar materials were observed at several points along the Neuse river and also at one locality on the Great Pee Dee river in South Carolina. A small collection of identifiable leaves was made in the vicinity of Blackmans Bluff on the Neuse river, at which locality about twenty feet of transitional Cretaceous is exposed. Some of

the lignite at this locality was observed to contain amber in small drops, in this respect resembling the Cretaceous deposits of Staten Island, New Jersey, Delaware and Maryland. As previously mentioned, some of the sandy lignitic exposures on the lower Cape Fear river were observed to contain leaves, and in my notes the following are recorded from near Big Sugar Loaf Landing: *Magnolia*, *Laurus*, *Ficus daphnogenoides*, *Sequoia heterophylla*, cone-impression, and fragments of a fern. It was impossible to save this material, so that these identifications may be regarded as tentative for the present.

In the preserved material there are twenty-nine recognizable species. Of these, seven were described by Heer from Greenland, seven were originally described from the Dakota group, and seven were originally described from the New Jersey Raritan. In addition Newberry identified in the Raritan eight more of these species which were originally described by Heer or Lesquereux from other regions than New Jersey. A number of the forms, like *Andromeda Parlatorii* Heer, *Diospyros primaeva* Heer, *Ficus daphnogenoides* (Heer) Berry, and *Sequoia heterophylla* Velen., have been found at nearly all of the localities for Cretaceous plants of Atane, Raritan, Dakota and Magothy age, so that they may be omitted from our calculations.

There are seven forms in this contribution which it has not been possible to identify with previously described remains and which are here described as new. Of these *Quercus* and *Pterospermites* point to the beds being slightly more recent than the Raritan, as does the occurrence of species like *Cinnamomum Heeri* Lesq. and *Magnolia Capellinii* Heer, which are Dakota group plants recorded from the Magothy formation, but not with certainty from the Raritan; although Lesquereux recorded both from beds of that age in his report to George H. Cook included in the clay report of 1878. The striking absence of gymnosperms and pteridophytes, both in North Carolina and Alabama, as compared with New Jersey, may possibly indicate that the physical conditions of the region favored the replacement of the gymnosperms of farther north by evergreen dicotyledons; and the ferns, always a fragmentary and infrequent element in the middle and later Mesozoic floras, were simply not preserved or have not been

discovered. A fact of considerable botanical interest is the entire absence of any species of *Laurus* or *Salix* in North Carolina, both genera furnishing a large number and variety of leaves at most Cretaceous localities. Thus, there are 10 species of *Laurus* in the Dakota flora besides the allied genera *Laurophyllum*, *Lindera*, and *Malapoenna*, and 10 species of *Salix*. The New Jersey Raritan has 5 species of *Salix*, 1 of *Laurus*, and 3 of *Laurophyllum*. The Magothy has 4 species of *Laurus*, 1 of *Laurophyllum*, 1 of *Malapoenna*, and 4 of *Salix*.

This absence of laurels and willows is also a feature of the Tuscaloosa formation in Alabama, one very liable to modification, however, when the floras are thoroughly collected and studied.

Because of their geographical position these beds should be provisionally correlated with the Tuscaloosa formation of Alabama; with this reservation, however, that the Tuscaloosa flora, as far as it is known, coincides with that of the Raritan. Lithologically these North Carolina beds are much more like the Magothy of New Jersey, Delaware and Maryland than they are like the Raritan, and it seems probable that when the problem has been worked out for the whole coastal plain it will be found that the Tuscaloosa formation of Alabama as a whole includes sediments of Older Potomac, Raritan and Magothy age, while what is here called the Tuscaloosa formation in North Carolina, already differentiated from the Older Potomac, includes phases corresponding to both the Raritan and Magothy formations of the more northern portions of the coastal plain and to the upper Tuscaloosa and Eutaw formations of the Gulf region.

Except in one or two cases where it seemed desirable, the copious synonymy has been omitted, although in some instances a second citation is added to that of the author of the name in order to refer to especially well illustrated material.

GYMNOSPERMAE

CONIFERALES

SEQUOIA HETEROPHYLLA Velen. *Gymnosp. Böhm. Kreidef.* 22. *pl.* 12. *f.* 12; *pl.* 13. *f.* 2-4, 6-9. 1885. — Hollick, *Trans. N. Y. Acad. Sci.* 12: 3. *pl.* 1. *f.* 18. 1892. — Smith, *Geol. Coastal Plain Ala.* 348. 1894. — Ward, *Ann. Rep. U. S. Geol. Surv.*

15 : 378, 380, 382, 392. 1895. — Newb. Fl. Amboy Clays 49. *pl. 6. f. 1-13*. 1896. — Knowlton, Bull. U. S. Geol. Surv. **257** : 132. *pl. 16. f. 5*. 1905. — Berry, Bull. Torrey Club **33** : 165. 1906. — Rep. State Geol. New Jersey **1905** : 139. 1906.

This is the only species of gymnosperm contained in the Carolina material and it is but sparingly represented. Described originally from Bohemia (Cenomanian and Senonian) by Velenovsky, it was recorded in abundance from the Raritan of New Jersey by Newberry, from Staten Island by Hollick, from Delaware and Maryland by the writer, and from Alabama by Smith, so that it is not surprising that it should be found in an intervening region. Knowlton, who records a specimen from the Judith river beds of Montana, quotes Ward (*loc. cit.*) as the authority for its occurrence in the so-called lower and upper Albirupian of Virginia. A reference to the original is indecisive, and since beds of Raritan or Magothy age, with which the Albirupian is generally correlated, are not known to occur in Virginia, the specimen upon which Ward based his statement probably came from some locality in Maryland.

ANGIOSPERMAE

GRAMINALES (?)

PHRAGMITES sp.

PLATE 11, FIGURE 5

While from a perusal of the literature it would seem that almost anything is eligible for reference to the genus *Phragmites*, nevertheless there are in the collections from Court House Bluff several well-marked fragments which are clearly referable to this genus, without however implying generic relationship with the existing members of the genus.

While these remains are too imperfect to be of much value, they deserve to be recorded as showing the presence of monocotyledons in the Cretaceous flora of the region. The largest fragment, which is that figured, is 4 cm. in length by 11 mm. in width, with ten well-marked veins, all equal in calibre and with finer striations between them, and occasional transverse veinlets discernable. There is a close resemblance to the Long Island remains which Hollick calls *Poacites*,* but since the original use of this

* Bull. N. Y. Bot. Garden **3** : 411. *pl. 73. f. 1*. 1904.

term by Brongniart * should preclude it from Mesozoic terminology, the term *Phragmites* is preferable.

MYRICALES

***Myrica elegans* sp. nov.**

PLATE II, FIGURES 1-4, 6

Leaves 4-7 cm. long and 1.5-2 cm. wide, broadly lanceolate in outline. Like the living species, the margin is variable, ranging from forms in which it is rather angularly crenate with an approach to serrate in some of the teeth, through forms in which the crenations become more and more rounded until the other extreme shows relatively broad-bladed leaves with scalloped margins. The latter are quite different in appearance from the former, but are united to them by many intermediate forms of which the more pronounced types are figured. Midrib straight, moderately stout, petiole, if present, not preserved, secondaries numerous, 9-12 on a side, sub-opposite, equidistant, leaving the midrib at a wide angle which becomes more acute toward the tip of the leaf, curving slightly and running directly to the marginal points.

This is perhaps the commonest species at Court House Landing, and is represented by many individuals all more or less imperfect because of the arenaceous nature of the matrix and the presence of more or less gypsum. There is no *Myrica* recorded from the Tuscaloosa formation in Alabama. In New Jersey the Raritan has five or six species, of which *Myrica Newberryana*, *M. raritensis* and *M. acuta* are somewhat similar to the Carolina leaf but still entirely distinct, *Myrica raritensis* Hollick being a descendant in all probability of *Myrica brookensis* Font., the single species known from the Older Potomac of Virginia. There are two species found in the Cretaceous of Staten Island, two in the Magothy formation of New Jersey and Maryland, and nine or ten in the Dakota group of the west, all very distinct from the leaf in hand.

Myrica occurs earlier and is much more varied in America than in Europe, where the maximum development seems to have been during the Tertiary, the few Cenomanian and Senonian species not showing any similarities to the leaves under consideration. The Greenland Cretaceous furnishes five species, one of which, *Myrica praecox* Heer, from the Patoot beds of the west coast (Senonian?), resembles *Myrica elegans* more closely than

* Mém. Mus. Hist. Nat. 8 : 138. 1822.

any other leaves with which comparisons have been made. It is a somewhat smaller leaf with a rounded tip and marginal crenations which are wide but lacking the crenulations of the rounded crenations of the Carolina leaf. Various American Tertiary species of *Myrica* are similar enough to be looked upon as possible descendants of this Cretaceous species; for instance, Lesquereux's *Myrica rigida* and *M. callicomaefolia* from the Green river shales. There is considerable resemblance to a number of European Tertiary species, hardly worth noting however in this connection. There is also a general resemblance to those Tertiary forms which Heer and Unger referred to *Comptonia vindobonensis*, except that the margin is serrated in the latter, while in those leaves which lack the serrations, as those which Ettingshausen and Saporta have referred to this species, the leaf is long and narrow. Among leaves which might be mistaken for *Myrica*, similarities may be noticed to some of the leaves which Lesquereux refers to *Rhus*, e. g., *Rhus acuminata*, while the leaves of some species of *Quercus* often approach this style of leaf as may be seen in *Quercus Marioni* Heer and *Quercus Johnstrupi* Heer from the Greenland Cretaceous.

FAGALES

***Quercus Pratti* sp. nov.**

PLATE II, FIGURE 9

A single fragment of what was rather a good-sized leaf of *Quercus* occurs in the material from Court House Bluff. It is 6 cm. long and 3.5 cm. wide, and does not show base, tip or margins. The midrib is stout and flexuous, although the latter character seems to be due to the manner of preservation which has bent what would be otherwise a straight midrib. Secondaries numerous, regular, parallel, alternate and stout; they leave the midrib at a wide angle and are nearly straight.

This fragment closely resembles *Quercus Ellsworthiana* and *Q. Wardiana* from the Dakota group, and if the outline was also analogous to that of those leaves, it would show an ovate or obovate, rather thick leaf with a repand or undulate margin, remotely suggestive of the modern chestnut oaks. There is also some resemblance to the leaves which Lesquereux refers to *Juglandites*, and to *Quercus sphenobasis* Hos. & V. D. Marck from the Senonian of Westphalia.

Quercus is a decidedly upper Cretaceous and later type, for

while three species of *Quercophyllum* have been described from the older Potomac of Virginia their botanical relations are extremely doubtful. The New Jersey Raritan has yielded but a single fragment of a leaf which Newberry doubtfully refers to *Quercus Johnstrupi* Heer, while there are none reported from Alabama, although six are known from the Magothy formation. Nor is the genus present in the lower Cretaceous of England, Portugal, or Bohemia. In Greenland the Atane beds have six species and the Patoot beds eight, while the Dakota group contains the remarkable number of eighteen, exceeding even the number in the European Senonian, where *Quercus* is so prominent an element.

URTICALES

***Planera cretacea* sp. nov.**

PLATE 11, FIGURES 7, 8

Ovate-lanceolate, rather unsymmetrical leaves, 3–7 cm. long, by 1–2.7 cm. wide, tapering at the base and tip, the latter gradually narrowing to an acute point. Margin entire below, with sharply serrate teeth above. Midrib moderately stout. Secondaries leaving the midrib at an acute angle, alternate or sub-opposite, parallel and curving, becoming obliterated toward their tips in the lower part of the leaf and extending into the serrations in the upper part. Represented by several imperfect specimens from Blackman's Bluff and two or three better preserved fragments from the locality one half mile below Blackmans Bluff on the Neuse river.

Planera seems to be unknown in the Mesozoic rocks of Europe, while the various forms found in the Tertiary of that region, often showing a considerable range in variation, are referred to the single comprehensive and probably polymorphic species *Planera Ungerii* Ettings.

In this country there is one species in the Raritan of New Jersey* and a second in the Patoot beds of the west coast of Greenland, both smaller and quite distinct from the Carolina leaf, which does, however, somewhat resemble *Carpinites microphyllus* and *Betula atavina* Heer from the Patoot beds. The genus is largely developed in the American Eocene with six or seven species, the Green river shales furnishing the majority of forms, and at the famous locality of Florissant,† Colorado, containing hundreds of

* Hollick has recently described a fragmentary leaf from Gay Head, Marthas Vineyard, as *Planera betuloides*. U. S. Geol. Surv. Monog. 50 : 57. pl. 8. f. 22. 1906.

† Possibly of Oligocene age.

specimens. The existing species, which is so common in our southern states, has been found as far north as New Jersey in the Pleistocene.

FICUS DAPHNOGENOIDES (Heer) Berry, Bull. Torrey Club **32** : 329. *pl.* 21. 1905. PLATE 11, FIGURES 10, 11

This widespread Cretaceous species, previously recorded from the coastal plain of Marthas Vineyard, Long Island, Staten Island, New Jersey, Maryland, and Alabama, is represented by a number of imperfect specimens from Court House Bluff.

FICUS WOOLSONI Newb.; Hollick, Trans. N. Y. Acad. Sci. **12** : 33. *pl.* 2. *f.* 1, 2*c.* 1892. PLATE 12, FIGURE 1

This determination is based on the single imperfect specimen from Court House Bluff shown in the figure. The species is abundant in the New Jersey Raritan, and has also been recorded from Staten Island, Delaware, and the Tuscaloosa formation of Alabama.

FICUS INAEQUALIS Lesq. Fl. Dakota Group 82. *pl.* 49. *f.* 6-9 ; *pl.* 50. *f.* 3. 1892. PLATE 12, FIGURES 2, 3

There are a number of imperfect specimens in the material from Court House Bluff which have been referred to this species. Originally described from Kansas, it has been detected by Smith in the Tuscaloosa of Alabama. The North Carolina leaves differ somewhat from Lesquereux's type, being somewhat larger with more remote secondaries. The leaf-substance does not appear to be thickened and the venation is rather thin for this genus. The leaves are markedly inequilateral and show a tendency in their lower secondaries toward a palmate venation, which is only suggested, however.

RANALES

DEWALQUEA GRÖNLANDICA Heer, Fl. Foss. Arct. **6**² : 87. *pl.* 29. *f.* 18, 19 ; *pl.* 42. *f.* 5, 6 ; *pl.* 44. *f.* 11. 1882.

Another widespread Cretaceous form of doubtful botanical affinity. The present material is imperfect and comes from Blackmans Bluff. The species, which was described originally from Greenland, has been collected on Staten Island, and in New Jersey and Alabama.

MAGNOLIA CAPELLINII Heer, Phyll. Crét. Nebr. 21. *pl.* 3. *f.* 5, 6.
1866. PLATE 12, FIGURES 4, 5

A clearly defined and widespread Cretaceous species represented by several good specimens in the material from Court House Bluff, which, taken together, show the whole leaf with the exception of a small portion of the extreme base. The texture is coriaceous, the midrib is straight and stout, the secondaries are regular, alternate and camptodrome; the tip is acute and very slightly produced as in some of Heer's forms from Greenland,* in fact, the Carolina leaves resemble more closely those from Greenland than they do the other leaves which have been referred to this species. It is true that Heer includes a leaf with a rounded tip with the others but this should probably be referred to the same author's *Magnolia obtusata*. The type leaves from Nebraska as well as those from Long Island and New Jersey are somewhat smaller. The species has also been recorded from Vancouver Island by Dawson and from Bohemia by Velenovsky, although the leaves which the latter figures as *Magnolia Capellini* are rather doubtful fragments and not nearly so similar to the other leaves of this species as, for instance, his *pl.* 7, *f.* 7, which he identifies as *Magnolia amplifolia* Heer.

Magnolia Newberryi

PLATE 13, FIGURE 6

Magnolia longifolia Newb.; Hollick, Trans. N. Y. Acad. Sci. 12 :
36. *pl.* 3. *f.* 9. 1892. (Not *M. longifolia* Sweet.)

This leaf has already been found on Marthas Vineyard and Staten Island, at Woodbridge, New Jersey, and in the Tuscaloosa formation in Alabama. It is one of the largest of our fossil magnolias, its oblong leaves sometimes measuring a foot in length and four inches in width. The North Carolina material is from Court House Bluff and consists of the specimen figured and its counterpart. It shows the imperfect central part of a large leaf and is 11 cm. long by 5.5 cm. in width and does not show either margins, tip or base indicating that the entire leaf fully equaled some of Newberry's larger leaves in size. The midrib is very strong as are the characteristic secondaries.

The name given to this species by Newberry had unfortunately

* HEER, Fl. Foss. Arct. 6² : *pl.* 25. *f.* 1, 3; *pl.* 45. *f.* 1. 1882.

been used by Sweet * for an existing species and therefore has to be abandoned, while *macrophylla*, which at once suggests itself, was used by Vukotinovic in 1870 for a fossil species, so that the species under consideration may well be named in honor of its describer, Professor Newberry.

***Liriodendron dubium* sp. nov.**

PLATE 14, FIGURE 3

Leaf about 6–7 cm. long and 5 cm. broad at the widest part, which is in the lower half of the leaf. The petiole is not preserved but the midrib is very thick. The secondaries are all of small calibre, of equal rank and very numerous; they branch from the midrib at an angle of 45 to 50 degrees and are nearly straight and parallel. The tip, which is not preserved, was probably pointed. There are two lateral lobes on the perfect side of the specimen. Basal part of the leaf roughly semicircular in outline and markedly decurrent. The only tertiary venation shown is the small straight nervilles connecting the secondaries, the venation being obscured toward the margin.

While this species is founded upon the imperfect specimen figured and its counterpart, there is little doubt of its affinities with the Cretaceous species of *Liriodendron*. It is just the size of *Liriodendron primaevum* and *L. Meekii* and of *Liriodendropsis simplex* and *L. angustifolia*, being wider, however, than the latter. The venation is of exactly the type which obtains in the two latter species, and the thick midrib is an additional character of most of the species of *Liriodendron*. While the outline is not that which we are accustomed to associate with this genus, there are many modern *Liriodendron* leaves which approximate it and one such is reproduced on PLATE 14 for comparison. With regard to the stage of *Liriodendron* development represented it may be said that while the venation has not advanced beyond the *Liriodendropsis* type the outline is somewhat beyond *Liriodendron primaevum* and *L. Meekii*, even hinting at that of *Liriodendron oblongifolium*, retaining however, in all probability, the pointed tip of the progenitor of the genus, although this is conjectural, and there may have been another pointed lobe on each side and an apical sinus between them as in *L. oblongifolium*. However, pointed leaves in this genus are not the anomaly that they seem to be, for we already have one fossil species with a pointed tip, *Liriodendron semialatum* Lesq.

* Hort. Brit. 11. 1826 (Ed. 1).

from the Dakota group, and the writer has collected a variety of pointed leaves from the modern tree, a number of which have already been figured.*

LIRIODENDRON sp. (*cf.* L. PRIMAEVUM Newb.).

Collections made at Blackmans Bluff on the Neuse river contained a small-leaved *Liriodendron* which appears in my notes under the above heading. The specimen was destroyed in transit so there is no means of telling except in the light of future collections whether this was simply a leaf of the preceding species or whether Newberry's species is represented. Both species of *Liriodendropsis* occur in the Tuscaloosa clays of Alabama, and it would not be at all surprising to find *Liriodendron primævum* also present.

SAPINDALES

CELASTROPHYLLUM CRENATUM Heer, Fl. Foss. Arct. 7: 41. *pl.* 62. *f.* 21. 1883. — Newb. Fl. Amboy Clays 99. *pl.* 48. *f.* 1-19. 1896.

PLATE 13, FIGURE 5

As Newberry well says, Heer's type of this species is in many ways more like the Raritan *C. Newberryanum* than it is like the leaves which he hesitatingly refers to Heer's species, still the latter vary greatly in size and outline and some are so close to the type that he did not feel justified in considering them distinct. The North Carolina specimen is a practically complete leaf 7 cm. long by 4 cm. wide, about the size of the largest of those figured by Newberry, somewhat obovate in general outline with an inequilateral base. It is comparatively somewhat narrower than the New Jersey leaves and the secondaries are more remote than in the majority figured. The venation is otherwise identical. The margin is very similar, the coarse crenations, if anything, being more aquiline and like those of *C. undulatum* Newb. as shown on *pl.* 26, *f.* 2 of the Amboy Clay flora. The summit is rounded. The marginal teeth are somewhat variable and disappear entirely toward the base of the leaf. The petiole is not preserved.

This is a remarkably fine species and typical of the leaves referred to this genus as it is so largely developed during mid-Cretaceous times. Both this species and *C. undulatum* Newb. are

* BERRY, Torreya 2: *pl.* 1. *f.* 4, 11; *pl.* 2. *f.* 12-15. 1902.

reported from the Tuscaloosa clays of Alabama, while the New Jersey Raritan has ten species, the Magothy two, the Dakota group six and Greenland five. It is represented in the Cenomanian of Europe and Saporta & Marion record seven species from the Paleocene of Belgium. It is also represented at later geological horizons, while several species are recorded from the Older Potomac beds.

RHAMNALES

CHONDROPHYLLUM NORDENSKIÖLDI Heer, Fl. Foss. Arct. 3²: 114.
pl. 32. f. 11, 12; pl. 30. f. 4b. 1874. PLATE 13, FIGURE 1

This leaf is intermediate in outline between *C. Nordenskiöldi* and *C. orbiculatum* Heer, from the Atane beds of Greenland. It approaches the former in general outline and also resembles it more closely in the character of the venation, differing in the possession of a wider, apparently slightly sheathing base, although this feature as shown in the specimen may be due to pressure acting on a short and stout petiole. Outline somewhat obovate instead of oval.

C. orbiculatum is not very different from Heer's other species, but has a thicker midrib, pinnate secondaries, and orbicular form. Two additional species are referred to this genus from the New Jersey Raritan, both of which are entirely distinct from the Carolina leaf. In addition, *C. orbiculatum* has been reported from Staten Island, and Lesquereux has identified both this and Heer's other species in the Dakota group, referring them to the genus *Hedera* where they may possibly rightly belong. The North Carolina material comes from one half mile below Blackmans Bluff on the upper Neuse river.

MALVALES

Pterospermites carolinensis sp. nov.

PLATE 14, FIGURE 2

Rather thick, broadly ovate leaves with a slightly cordate base, about 10 cm. long by 6.5 cm. broad. Margin entire except in the upper part of the leaf, where it was probably undulate as there is an indication of such on the left margin just below where the leaf is broken away. Petiole preserved for 1.5 cm., very stout. Midrib straight, stout, becoming enlarged below to join the petiole. Secondaries subopposite, strong, distant, two pairs branching from the base of the midrib, the lower at an angle of nearly 90 degrees, giving off several tertiaries which arch along the margin; the

second branching at an angle of about 45 degrees, strong and nearly straight, giving off 5 or 6 camptodrome branches on the marginal side ; in fact what has been called the lowest secondary may be a branch of this vein which separates from it at its extreme base. Balance of the secondaries branch at an angle of about 50 degrees and are more curved upward in their courses. Nervilles largely simple, straight or curved.

Represented in the collections from Court House Landing, North Carolina, by the specimen figured and its incomplete counterpart.

There are two recorded species of *Pterospermites* in the United States Cretaceous, one (*P. modestus* Lesq.) occurring on Staten Island and in the Tuscaloosa of Alabama, both of which are very distinct from the Carolina leaf, which does, however, resemble somewhat one of the two species (*P. cordifolius*) which Heer records from the Atane beds of the west coast of Greenland. There is also considerable resemblance to the leaves from the Wyoming Laramie referred by Lesquereux to *Apeibopsis? discolor*, and to several of the leaves of *Ficus* found in the Montana formation.

During the Eocene there were species in Alaska and Europe and the genus continued through the Tertiary with upwards of a dozen species in the Miocene.

***Pterospermites credneriifolius* sp. nov.** PLATE 13, FIGURE 4.

This species is unfortunately founded upon an imperfect specimen, 5 cm. long by 4 cm. wide, of the terminal part of a leaf with truncated apex and slightly dentate margin. The midrib is stout and widens rather rapidly below. Secondaries regular, sharply defined but thin, branching from the midrib at an acute angle and running with but a slight curve to the marginal dentations.

If leaves of the genus *Credneria* Zenker, which form so prominent an element in the upper Cretaceous floras of Europe, were commonly recognized in America, I would say that this leaf was referable to that genus ; or, did the remains consist of more extensive or complete material, it might be possible to identify it with the *Credneria denticulata* of Zenker, which Richter* makes a variety of *Credneria Zenkeri* and which is abundant in the Senonian

* RICHTER, Die Gattung *Credneria* Zenker. 13. pl. 2. f. 6, 7 ; pl. 6. f. 1, 12. Engelmann, Leipzig, 1906.

of Saxony. To be sure, certain Dakota group leaves such as *Populites* = *Platanus* = *Cissites affinis* Lesq., *Cissites Brownii* Lesq., *Sassafras* = *Cissites harkerianus* Lesq., *Cissites* = *Platanus Heerii* Lesq., *Cissites acuminatus* Lesq., and *Sterculia Saportanea* (Lesq.) Knowlton seem very similar to those remains from abroad which are referred to *Credneria*, but the proof or disproof of their generic identity can only be determined by a critical investigation and revision of the whole subject.

While such incomplete material as we have from Court House Bluff, North Carolina, is scarcely worthy of being described as a new species, nevertheless since it is likely to be referred to it has seemed best to give it a name and one which would suggest the possible generic affinity which it is hoped may be verified at some future time.

THYMELAEALES

CINNAMOMUM HEERII Lesq. Am. Jour. Sci. 27: 361. 1859. —
Fl. Dakota Group 105. *pl. 15. f. 1.* 1892.

PLATE 13, FIGURES 2, 3

This species is very close to *Cinnamomum intermedium*, from which it differs in having a shorter, fuller, and basally rounded leaf-blade with thicker veins. Leaves are so rarely found in a perfect state, and basal portions of *Cinnamomum* leaves being those largely collected, we may distinguish such fragments by the much fuller and rounded base combined with the thicker veins. The species which Newberry called *C. intermedium* is such a common form that I have no doubt if we could identify the leaves of all stages of growth we would find that *C. Heerii* was simply the shorter fuller leaves of the same tree which bore the more lanceolate leaves known as *C. intermedium*. At least this is my opinion of the leaves as they occur in the Dakota group and Magothy. The leaves from Nanaimo and Orcas Island referred to *C. Heerii* by Lesquereux and Newberry respectively seem to be different, but as I have only seen figures this cannot be certain. *C. Heerii* is reported from Texas by Knowlton, from Marthas Vineyard by Hollick, and from South America by Kurtz. It is another of those types of leaf, evidently Lauraceous, which are so common on this continent during the later Mesozoic and in Europe during the Tertiary.

The North Carolina material is from Court House Bluff.

UMBELLALES

Aralia Newberryi

PLATE 15, FIGURE 1

Aralia palmata Newb. Fl. Amboy Clays 117. *pl.* 39. *f.* 6, 7; *pl.* 40. *f.* 3. 1896.

Since this name has been used several times for members of the living flora, I have changed it as above.

This fragment of a trilobed leaf from Court House Bluff seems allied to this species of *Aralia*, especially to those forms from New Jersey referred to it by the writer. There are a variety of similar leaves which have been described from New Jersey and elsewhere in the genera *Aralia*, *Sassafras*, etc., without any definite understanding of their true affinity. Thus this leaf is somewhat similar to *Aralia grönlandica* Heer, to *Sassafras hastatum* Newb., and to some of the forms which have been referred to *Sassafras acutilobum* Lesq. Without the basal part of the leaf it is impossible to identify it except provisionally.

HEDERA PRIMORDIALIS Sap. Le Monde des Pl. 200. *f.* 29. 1879.

— Newb. Fl. Amboy Clays 113. *pl.* 19. *f.* 1, 9; *pl.* 37. *f.* 1-7. 1896.

PLATE 16

Leaves of this type appear to be rather common at Court House Bluff and they agree very well with this species. While none were found in a perfect condition, figures 1, 3 and 4 give us nearly the whole leaf except the tip. Shape reniform or cordate with a deep basal sinus and 4-6 primaries palmately branching from the top of the petiole, which was stout. Venation entirely characteristic of the species as illustrated by Newberry. This species is reported by Heer from the Atane beds of Greenland but his specimens are fragmentary and not entirely convincing. More typical specimens are illustrated by Velenovsky from the Cenomanian of Bohemia. The Carolina leaves are somewhat larger than the other leaves of this species but are otherwise manifestly identical. The genus *Hedera* is well characterized in the mid-Cretaceous by numerous species of Raritan and Dakota age.

MYRTALES

EUCALYPTUS GEINITZI Heer, Fl. Foss. Arct. 6²: 93. *pl.* 19. *f.* 1c, et seq. 1882.

PLATE 15, FIGURE 4

Myrtophyllum (*Eucalyptus*?) *Gcinitzi* Heer, Fl. Molettein 22. *pl.* 10. *f.* 3, 4. 1872.

Myrtophyllum Warderi Lesq. Fl. Dakota Group 136. *pl.* 53. *f.* 10. 1892.

Represented in the material from Court House Bluff by five fragmentary specimens beside the nearly perfect leaf figured. Leaf coriaceous but not thick, lanceolate, fully 18 cm. long, 2.2 cm. wide at the widest part which is near the middle from which point the leaf tapers nearly uniformly above and below, the margins being if anything slightly straighter below, decurring on the extremely stout petiole. Midrib also very stout, slightly flexuous, apparently prominent in life, while the secondaries were thin and nearly immersed in the leaf substance. Secondaries very numerous, leaving the midrib at a very acute angle curving outward slightly and then upward, and running parallel and straight to join the marginal vein, which forms a hem all around the leaf and is but slightly looped from secondary to secondary and less than one millimeter from the margin.

The genus *Myrtophyllum* was established by Heer in 1869 in his Molettein flora for leaves allied to *Eucalyptus*, with *Myrtophyllum* (*Eucalyptus*?) *Geinitzi* as the type. Having found similar leaves in Greenland and supposed *Eucalyptus* fruits at the same horizon, he referred this species to *Eucalyptus* without question in 1882, in vol. 6 of his Fl. Foss. Arct. A great variety of leaves have been referred to this species, while numerous other Cretaceous species of *Eucalyptus* have been described, some apparently identical with it. While the type carries the generic term *Myrtophyllum* with it into synonymy, that term should possibly be retained for the reason that when the present unsatisfactory state of our knowledge of these species is cleared up it is more than probable that *Myrtophyllum* will have to be retained for a part of the forms at present included under *E. Geinitzi*, and also because of the doubt as to their being *Eucalyptus* leaves at all, due to the discrediting of the fruits, so that it may be found desirable to drop the name *Eucalyptus* altogether and to take up *Myrtophyllum* for all of these leaves. *Myrtophyllum Warderi* was based on the lower half of a leaf from Kansas with which the Carolina material is identical. Some of the leaves referred to *E. Geinitzi* are also of this type, as, for instance, the Block Island leaf figured by Hollick (Ann. N. Y. Acad. Sci. 11: *pl.* 4. *f.* 1. 1898) which specimen has,

however, less ascending secondaries and a thinner midrib.* I have compared Lesquereux's type (2754 United States National Museum) with my material and with the figures of Heer's type and find that they are identical.

EUCALYPTUS? ATTENUATA Newb. Fl. Amboy Clays 111. *pl.* 16. *f.* 2, 3, 5. 1896.

A single fragment of a leaf identical with Newberry's New Jersey leaves, so named, is contained in the collection from Court House Bluff. This species has also been detected by the writer in the Magothy formation, and it is reported by Smith from the Tuscaloosa formation of Alabama.

Eucalyptus linearifolia

Eucalyptus? nervosa Newb. ; Hollick, Bull. Torrey Club 21 : 56. *pl.* 174. *f.* 10. 1894. — Newb. Fl. Amboy Clays 112. *pl.* 32. *f.* 3-5, 8. 1896.

Fragmentary remains of this species were found at Blackmans Bluff on the upper Neuse river. It is a form common in the coastal plain Cretaceous and has been reported from Block Island, Long Island, New Jersey and Alabama. Since Newberry's name is unfortunately preoccupied by *E. nervosa* F. Muell. (Miq. Nederl. Kruidk. Arch. 4 : 139. 1859) it becomes necessary to rename this species.

ERICALES

ANDROMEDA PARLATORII Heer, Phyll. Crét. Nebr. 18. *pl.* 1. *f.* 5. 1866. — Newb. Fl. Amboy Clays 120. *pl.* 31. *f.* 1-7 ; *pl.* 33. *f.* 1, 2, 4, 5. 1896. — Berry, Bull. Torrey Club 31 : 79. *pl.* 1. *f.* 1, 2. 1904.

PLATE 15, FIGURE 2

This ubiquitous species is represented in the collections from Court House Bluff by the basal part of two leaves similar to the one figured. These are larger than Heer's type but similar to the leaves from the coastal plain usually referred to this species, some figures of which are cited above. The species occurs in considerable numbers from Greenland to Alabama and west to Minnesota and Kansas.

* Hollick has recently transferred certain forms of *Eucalyptus Geinitzi* from Glen Cove, Long Island, to *Myrtophyllum Warderi*, keeping the two distinct. U. S. Geol. Surv. Monog. 50 : 97. *pl.* 35. *f.* 13. 1906.

ANDROMEDA NOVAE CAESAREAE Hollick, in Newb. Fl. Amboy Clays 121. *pl.* 42. *f.* 9-12, 28-31. 1896.

A single characteristic leaf of this species was found at Blackmans Bluff on the Neuse river. Described originally from the New Jersey Raritan, it has been detected by the writer in the Magothy formation at Grove Point, Maryland, and Smith has reported it from the Tuscaloosa formation of Alabama.

Andromeda grandifolia

Andromeda latifolia Newb. Fl. Amboy Clays 120. *pl.* 33. *f.* 6-10; *pl.* 34. *f.* 6-11; *pl.* 36. *f.* 10. 1896. PLATE 15, FIGURE 3

Leaves of irregular size, some becoming very large, with stout midrib, coriaceous texture, camptodrome venation, and a margin inclined to be repand or irregular. The botanical affinity of this species, which occurs with, and somewhat resembles *Andromeda Parlatorii*, is unknown. It has been found in New Jersey and Alabama and on Long Island. The Carolina leaf is of large size and was found at Court House Bluff.

It becomes necessary to rename this species since *Andromeda latifolia* Newb. is preoccupied by *A. latifolia* Wright, in Sauv. Anal. Acad. Ci. Habana 6: 250 (1870), a Cuban plant.

KALMIA BRITTONIANA Hollick (?), Trans. N. Y. Acad. Sci. 12: 34. *pl.* 2. *f.* 6-8. 1892.

A specimen of an Ericaceous leaf from one half mile below Blackmans Bluff on the Neuse river is provisionally referred to this species described from the Cretaceous of Staten Island; without implying that it is related to *Kalmia*, which is doubtful.

EBENALES

DIOSPYROS PRIMAeva Heer, Phyll. Crét. Nebr. 19. *pl.* 1. *f.* 6, 7. 1866.

Fragmentary specimens from Court House Bluff are rather larger than the usual run of leaves of this species but are otherwise identical. Many of these Cretaceous species from Carolina average larger in size, and it may be that this region was relatively more humid during the mid-Cretaceous. It is difficult to suppose that the temperature was higher, since all of the evidence derived from the floras has shown a uniform flora as far north as Green-

land with some of the species crossing the equator and extending to the southern part of South America.

This species is an abundant and widespread one ranging from Greenland to Alabama along the eastern coast and from Nebraska and Kansas to Texas in the interior region.

GENTIANALES

ACERATES sp., Hollick, in Newb. Fl. Amboy Clays 124. *pl.* 32. *f.* 17; *pl.* 41. *f.* 4, 5. 1896.

A specimen which is comparable to this Raritan species is contained in the material from one half mile below Blackmans Bluff on the Neuse river.

I doubt, however, whether any of these Cretaceous leaves described under this genus are related to the modern *Asclepiadaceae*, a highly specialized and recent type.

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Explanation of plates 11-16

PLATE 11

- Figs. 1-4, 6. *Myrica elegans* sp. nov. Court House Bluff, N. C.
Fig. 5. *Phragmites* sp. Court House Bluff, N. C.
Fig. 7. *Planera cretacea* sp. nov. One half mile below Blackmans Bluff, N. C.
Fig. 8. *Planera cretacea* sp. nov. Blackmans Bluff, N. C.
Fig. 9. *Quercus Pratti* sp. nov. Court House Bluff, N. C.
Figs. 10, 11. *Ficus daphnogenoides* (Heer) Berry. Court House Bluff, N. C.

PLATE 12

- Fig. 1. *Ficus Woolsoni* Newb. Court House Bluff, N. C.
Figs. 2, 3. *Ficus inaequalis* Lesq. Court House Bluff, N. C.
Figs. 4, 5. *Magnolia Capellinii* Heer. Court House Bluff, N. C.

PLATE 13

- Fig. 1. *Chondrophyllum Nordenskiöldi* Heer. One half mile below Blackmans Bluff, N. C.
Figs. 2, 3. *Cinnamomum Heerii* Lesq. Court House Bluff, N. C.
Fig. 4. *Pterospermites credneriifolius* sp. nov. Court House Bluff, N. C.
Fig. 5. *Celastrorhynchium crenatum* Heer. Court House Bluff, N. C.
Fig. 6. *Magnolia Newberryi* Berry. Court House Bluff, N. C.

PLATE 14

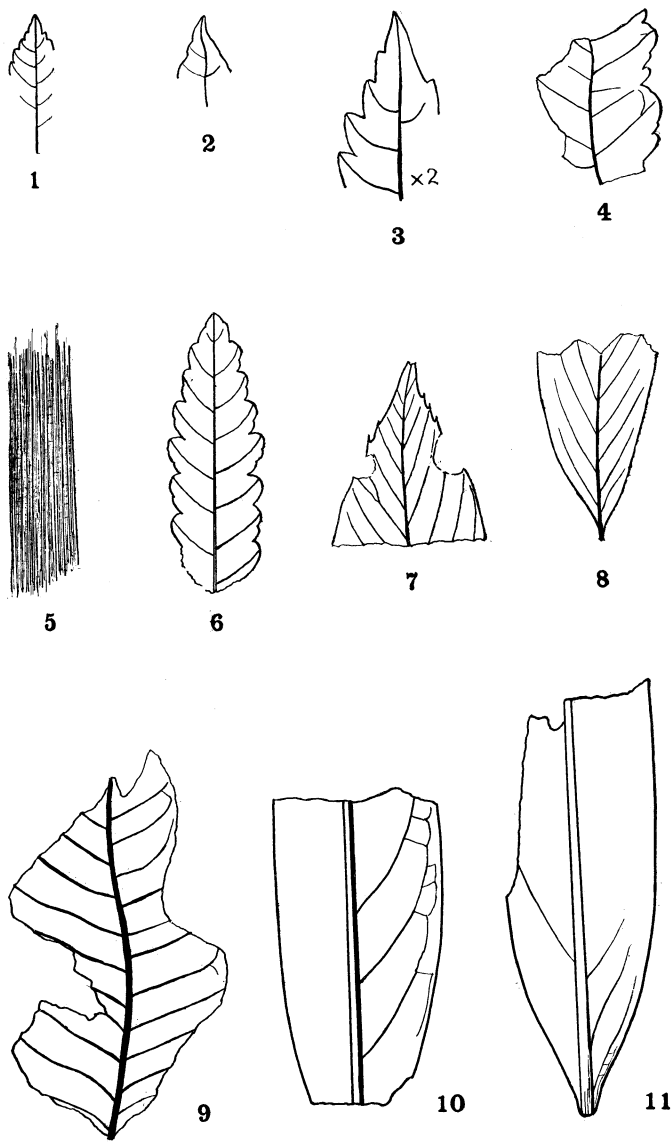
- Fig. 1. *Liriodendron tulipifera* Linn. Introduced for comparison.
Fig. 2. *Pterospermites carolinensis* sp. nov. Court House Bluff, N. C.
Fig. 3. *Liriodendron dubium* sp. nov. Court House Bluff, N. C.

PLATE 15

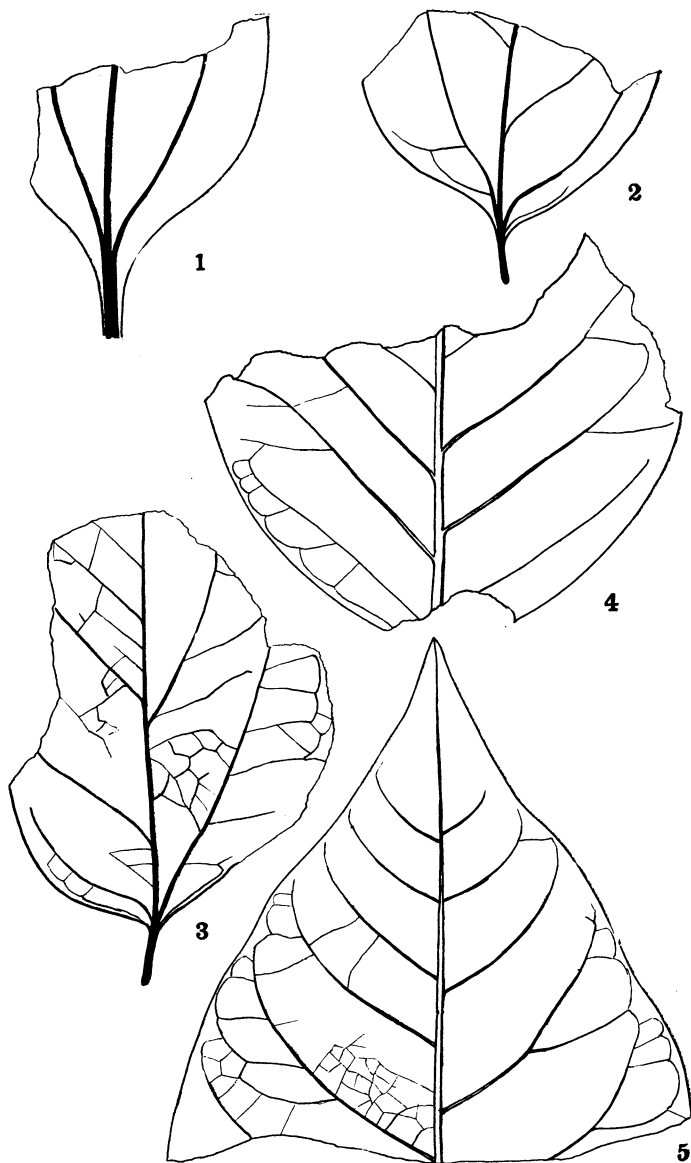
- Fig. 1. *Aralia Newberryi* Berry. Court House Bluff, N. C.
Fig. 2. *Andromeda Parlatorii* Heer. Court House Bluff, N. C.
Fig. 3. *Andromeda grandifolia* Berry. Court House Bluff, N. C.
Fig. 4. *Eucalyptus Geinitzi* Heer. Court House Bluff, N. C.

PLATE 16

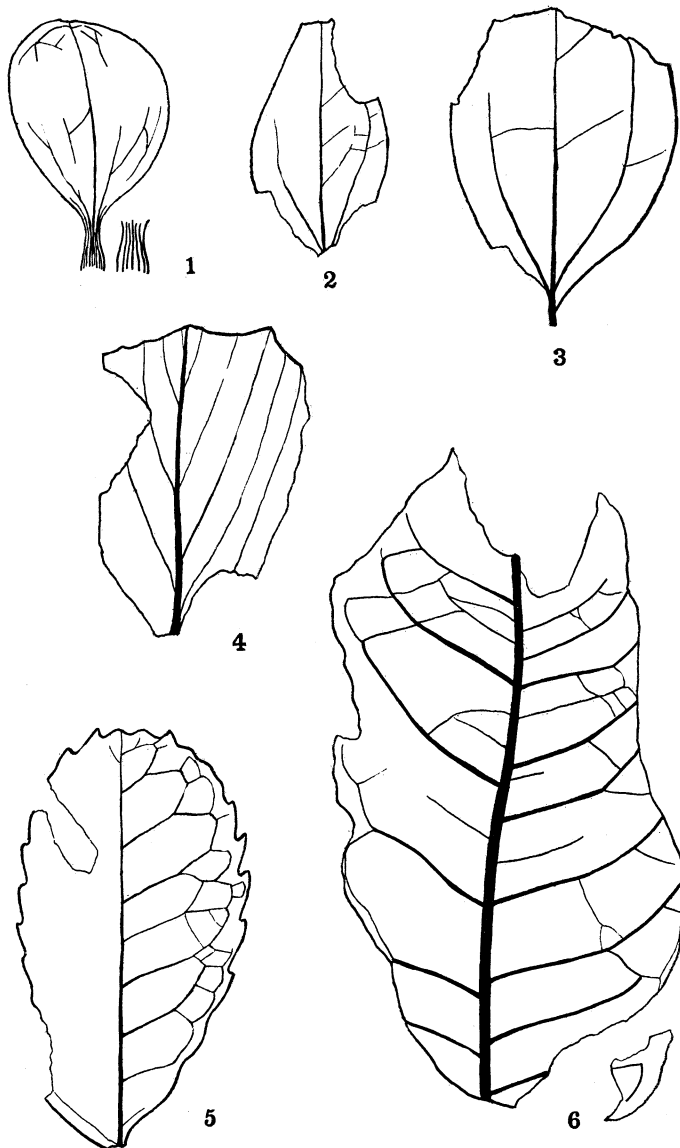
- Figs. 1-4. *Hedera primordialis* Sap. Court House Bluff, N. C.



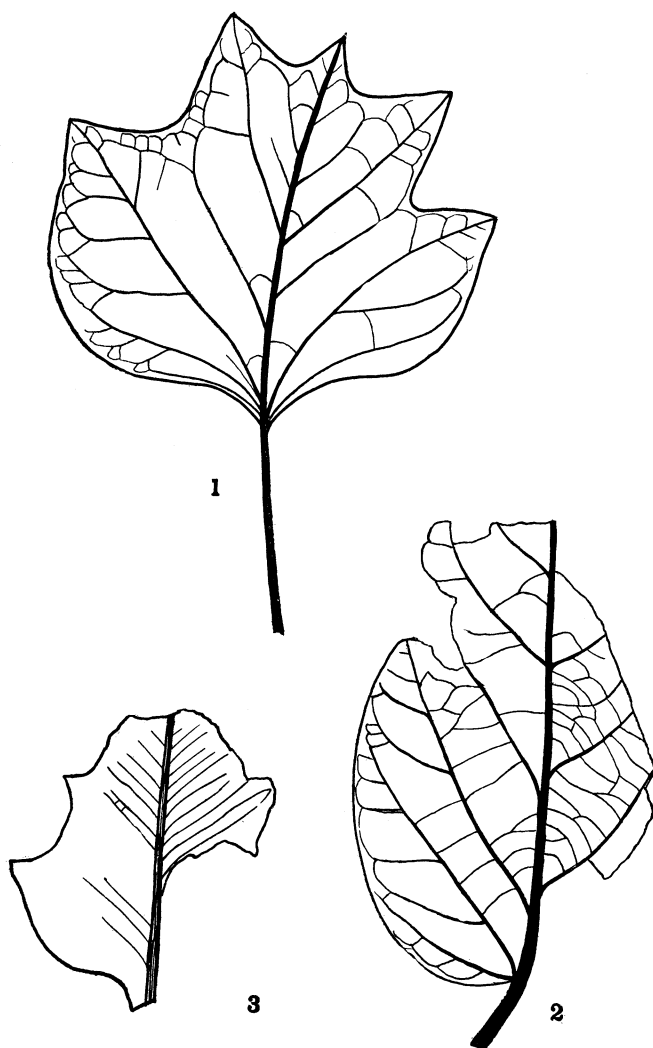
CRETACEOUS PLANTS FROM NORTH CAROLINA



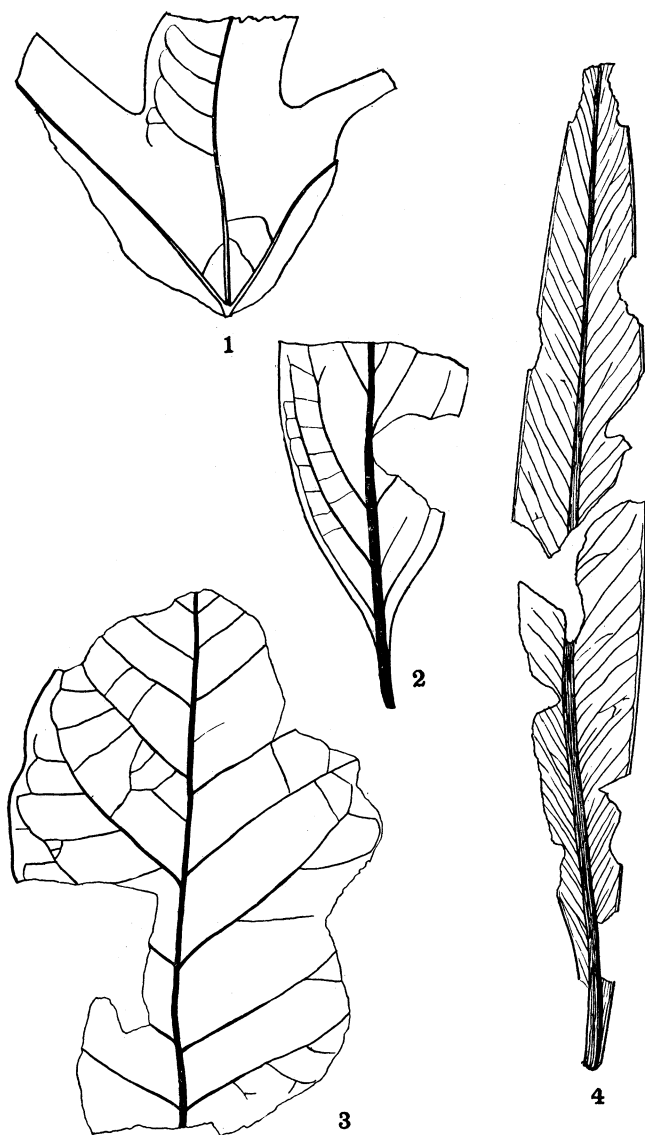
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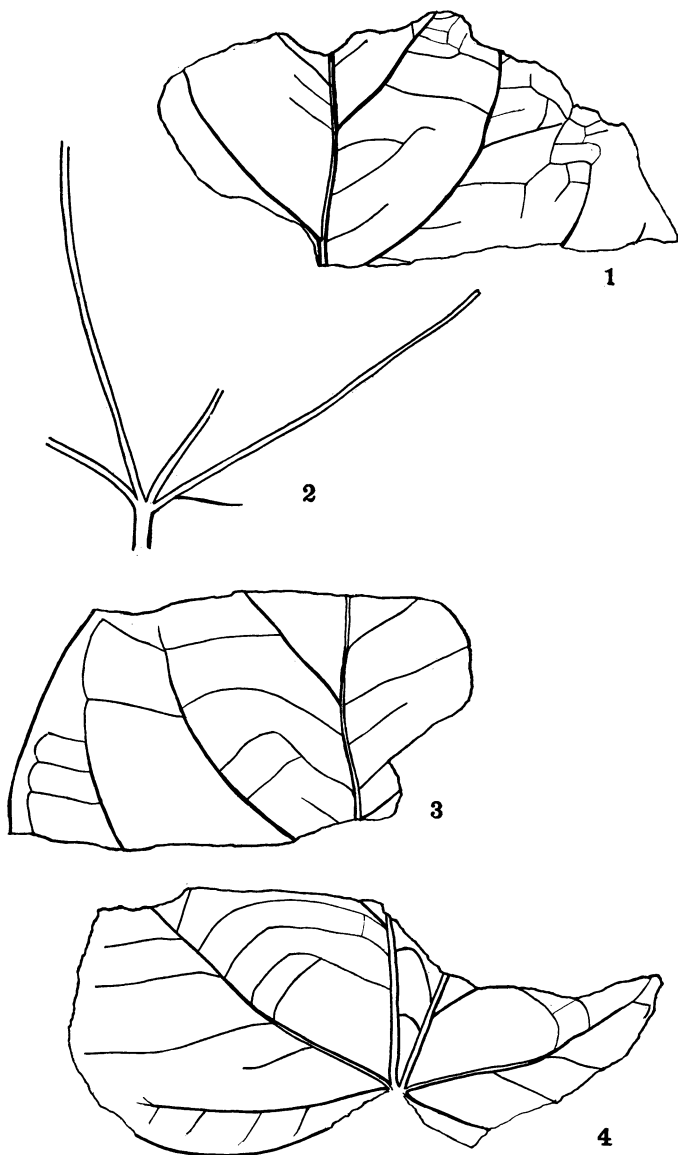
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